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EVALUATION OF BIOCHAR AS PRIMING AGENT FOR FINGER MILLET (*ELUSINECORACANA*) SEED PRIMING

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ABSTRACT

A study was carried out to evaluate biochars viz., redgram, soapbush wattle (Acacia holosericiae) and water hyacinthas priming agent for finger millet seed priming. The experiment was conducted with biochar extracts made to different concentrations viz., 1,2,3,4 and 5 per cent solution. The performance of biochar extracts were evaluated in terms of physiological seed quality parameters like speed of emergence, germination, root length, shoot length, dry matter production and vigour index. The individual results revealed that priming of finger millet seed with redgrambiochar @ 4% solution secured the best results in all physiological parameters when compared to control. Similarly, seed primed with soap bush wattle and water hyacinth biochars also showed greater increase in all the physiological parameters at 1% and 4% solution respectively compared to control. Among the biochars investigated, redgrambiochar primed seeds produced the vigorous seedlings followed by soapbush wattle. The biocharseed priming has a large scope in sustainable agriculture because of its significant improvement in physiological parameters for finger millet which is mostly cultivated as dryland crop.

KEYWORDS: Seed Priming, Biochars, Finger Millet, Improved Germination & Vigour

Original Article

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INTRODUCTION

Seed quality is one of the prerequisite for improving the germination and yield of plants, which done through seed management techniques (Komala *et al.*, 2011). Among the seed quality enhancement techniques, seed priming plays a major role in the recent years which means the controlled dehydration of seeds to a level that permit pregerminative metabolic activity to proceed but prevent actual emergence of radicle which increase the speed and uniformity in germination under the adverse condition of temperature. In recent days sustainable agriculture is getting increased through which we can supply the organic and nutrient rich products. In this line, biochara carbon rich material was used as priming material. Biochar is obtained by the pyrolysis process. In simpler terms, the biomass such as wood/manure /leaves is heated in no availability of air (Lehmann *et al.*, 2009). It is hyroscopic in nature and reduces the leaching effect which increased the root dry weight Robertson *et al*., 2012. It also aided to control global warming owing to its potential for reducing the emission of greenhouse gases in contrast to open air burning and decay of organic matter. In addition, biochar helped the sustainable management of massive agricultural and industrial waste (Woolf *et al*., 2010).

Because of its hygroscopic nature, in most of the investigations the biochar was used as soil application which need high amount of biochar. But in the present study, the biochar was used for seed enhancement technique through seed priming which need only little amount of biochar. This study was initiated to investigate the priming

effect of different biochars in finger millet seed. Finger millet is one of the nutricereals which is gaining more value as compared to other fine cereals like rice and wheat. It is cultivated for about 61.36 ha with the productivity of 1865 kg/ha in Tamil Nadu (Indiastat, 2017). Finger millet has an interesting fact that it is certain crop for the uncertain condition because it is mainly cultivated in rain fed areas (Sakamma *et al.*, 2017). It is considered as an important neutraceutical crop. Hence the priming treatment with different biochars were experimented in this crop seed to improve the germination and other physiological parameters which will be beneficial to the sustainable agriculture.

MATERIALS AND METHODS

The basic seed material of finger millet (*Elusinecoracana*) cv. CO 15 was collected from the Department of Millets, Tamil Nadu Agricultural University, Coimbatore. The biochar *viz.*, redgram and soapbush wattle (*Acacia holosericiae*) derived from stalks were obtained from Dryland Agricultural Research Station, Chettinad and water hyacinth derived from whole plant obtained from Department of Environmental Sciences, Tamil Nadu Agricultural University, Coimbatore. Then these biochars were ground and sieved to get fine powder. The laboratory studies were carried out in the Department of Seed Science and Technology, Tamilnadu Agricultural University, Coimbatore.

Preparation of Biochar Extract for Priming

The biochar extracts were prepared by immersing the biochars for different durations viz.,6, 12 and 24 hours in water/ethanol based on the solubility of biochar. The redgram and water hyacinthbiochars are soluble in water and soapbush wattle is soluble in ethanol. That biochars are to be soaked for 24 hours to get maximum extraction of nutrients from the biochars and then concentration was made to different per cent solutions like 1, 2, 3, 4 and 5%. The solutions were obtained by filtering through whatman number filter paper inorder to get the clear solution. After obtaining the solution, the finger millet seed was primed by adopting the seed to solution ratio of 1:1 and soaking duration of 6 hours and then dried back to original moisture content.

Speed of Germination

For each treatment twenty five seeds of four replicates were sown in petriplate top of paper method as per ISTA, 2013[7]. The seeds which are exposing the plumule were counted daily from the date of sowing until the final count day. Based on the seeds germinated, the speed of emergence was calculated using the following formula and the result was expressed in whole number (Maguire, 1962)

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots\ldots\ldots\ldots + \frac{X_n - X_{n-1}}{Y_n}$$

X1- Per cent seeds germinated at first count

X2- Per cent seeds germinated at second count

Xn- Per cent seeds germinated on nth day

Y1- Number of days from sowing to first count

Y2- Number of days from sowing to second count

Yn- Number of days from sowing to nth count

Germination Test

The germination test was conducted in the roll towel method in which the germination paper was used as the media. For each treatment, four replicates of hundred seeds were sown for conducting the germination test and kept in the germination room which is maintained at a temperature of 25±2°C and 95±1% RH. Then the final count was taken on eighth day where the seedlings were evaluated as normal, abnormal, dead seeds as per ISTA, 2013. The germination per cent was calculated using the following formula by using normal seedlings and then expressed in percentage.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds sown}} \times 100$$

Shoot Length (Cm)

Shoot length was taken from ten normal seedlings which was selected randomly from every replication and length was measured from the collar region to the tip of primary leaf (plumule) which was expressed in cm.

Root Length (Cm)

The same seedlings which was evaluated for shoot length was measured for the root length from collar region to tip of root (radicle) and expressed in cm.

Dry Matter Production (g/10 Seedlings)

Ten normal seedlings were selected from each treatments and replications and shade dried for 24 hours and was kept in hot air oven at 85°C for about 48hours. After drying period, the seedlings were cooled in closed desiccators over CaCO3 and were weighed in balance and the mean were expressed as dry matter production in gram per 10 seedlings.

Vigour Index

Based on the data obtained from germination per cent and seedling length, the vigour index values were computed using the following formula for each treatments and replications and the mean expressed in whole number (Abdul Baki and Anderson, 1973)

Vigour index = Germination % x Seedling length in cm (Root length + Shoot length)

Statistical Analysis

Data obtained were analysed for F test of significance following the methods described by Panse and Sukhatme (1985). Wherever necessary the values in the percent data were transformed using arcsine transformation.

RESULTS AND DISCUSSIONS

Priming of seeds is nothing but the soaking of seeds in solution, but restricts radicle protrusion until the primed seed are sown for germination (Vaibhav *et al*., 2017). So far many investigators used variety of priming agent for seed priming. But none of them used biochar as seed priming agent for improving the germination and other quality parameters. We are the pioneer in this study and used extracts derived from three different biochars as priming agent. The biochars *viz*., redgram, soapbush wattle, water hyacinth were used in different concentrations to evaluate the effect of type of biochar and also the concentration of biochar for priming of finger millet seed.

While evaluating the individual biochar, the biochar derived from redgram feedstock recorded significant differences for all the seed quality parameters studied. On comparison of different concentrations of biochar used, it was noted that 4% concentration was better than lower concentrations (1, 2 and 3%). Eventhough beyond 4%concentration, while the next level concentration of 5% was used, all the seed quality parameters were decreased but it was not less than control (Table 1). From this study, it was known that 4% redgram biochar could be used for priming of finger millet seed which improved the speed of germination, germination per cent, seedling length, dry matter production and the computed vigour index value to a tune of 27%, 21%, 20%, 23%, 47% and 48% respectively higher than control. Increased germination and seedling vigour through the biochar priming was due to presence of nutrients and nature of biochar that has been primed with seeds which was responsible for lesser inhibitory growth for seed germination. This was in line with Major (2009)in lettuce, radish and clover who used the biochar as soil amendment.

Biochar contains macro and micronutrients *viz*., N, P, K, Ca, Mg, Cu, Fe, Mn and Zn. Among the nutrients of biochar, calcium acted as enzyme cofactor in the process of germination which leads to increase in protein synthesis as reported by Christansen and Foy, 1979. The variation in physiological parameters obtained at different concentration was due to biphasic nature of biochar *i.e.* at low concentration it promotes the plant growth and vice versa at higher concentration (Muhammad *et al*., 2018). Zakaria *et al*., 2011 had also proved that all the plant attributes were decreased at higher concentration of biochar application in subterranean clover. The growth parameters like root length and shoot length was increased in biochar primed seeds because of the fertilizing effect of biochar resulted in nutrient release from damaged or decayed tissue of storage organ by hydrolysis as reported in sorghum (Shehzad *et al*., 2012). The addition of biochar improved the shoot length of lettuce plant (Mendez *et al*., 2017). Root biomass was increased by 20% due to application of biochar in wheat as revealed by Gebremedhin *et al.,* 2015. Whereas the root length was increased under drought condition to absorb water from deep soil (Nahar and Gretzmacher, 2011, Yousara *et al*., 2017) which was observed in soybean seedlings under drought stress. The increase in dry weight was due to early vigour and higher germination per cent because of which seedling reached the autotrophic stage in advance than in control (Srimathi *et al.,* 2007) which produced relatively higher amount of dry matter as reported in greengram. Yue *et al.,* 2017 observed that application of sludge derived biochar to the soil which significantly stimulated the growth and weight of turf grass by mineral nutrition enhancement in plant. In another study Khan *et al.,* 2013 revealed that growth parameters of rice were increased due to application of nutrient rich sewage sludge biochar. The increase in vigour index was due to inducement of growth promoting substances and translocation of secondary metabolites to the seedling growth.

For evaluation of type of biochar, the biochar from another feed stock soap bush wattle at various concentrations were used as priming agent for finger millet seed. In contrast to redgram biochar, where 4% concentration was better than 1,2 and 3% concentration, maximum speed of germination (4.82), germination per cent (91%), shoot length (4.2 cm), root length (13.3cm), dry matter production (0.028g/10 seedling) and vigour index (1591) were recorded in soap bush wattle biochar at the lowest concentration *i. e.* 1% rather than other concentrations and control (Table 2). The use of soapbush wattle biochar after 1%, gradually reduced the seed quality parameters due to the reason as dealt in redgram biochar. As that of redgram biochar, the biochar derived from water hyacinth revealed that 4% concentration was better than lower concentration of 1,2 and 3%. Here also the higher concentration 5% reduced the physiological parameters studied (Table 3). The reason was already discussed in the redgram biochar chapter.

Eventhough the individual biochars recorded higher values at different concentrations, all the biochars had significant effect in seed quality parameters. While comparing the three biochars, the redgram biochar out beated the other two biochars interms of vigour index. Regarding germination per cent, redgram biochar is on par with soapbush wattle biochar (Figure 1). The usage of a particular type of biochar is its intrinsic nutrient composition (rich or poor), which could produce varying results in the form of significant differences in plant growth (Deenik*et al*., 2016, Kim *et al*., 2013). This was in accordance with Gaskin *et al*. (2008), who reported that depending on the biomass type from which biochar is produced, biochar may contain traces to high concentrations of nutrients that could affect seed germination. Zakaria *et al*. (2011) also studied the influence of biochar type and rate on seed germination and seedling growth and reported the variation among the biochars. Root / shoot ratio decreased with higher rate of biochar application. Wheat seed germination was stimulated at 10t/ha soil application of biochar, but not for mung bean, inhibition of biochar occurred at the highest rate 100t/ha under the bioassay condition.

CONCLUSIONS

The finger millet seed priming with biochar as priming agent was influenced by type of biochar and concentration. All the biochars individually improved the seed quality parameters *viz*., speed of germination, germination per cent, root length, shoot length, dry matter production and vigour index at different concentrations. Among the three biochars investigated, redgrambiochar produced more vigorous seedlings than other two biochars *viz*., soapbush wattle and water hyacinth. From this study it is known that biochars have the great potentiality in seed enhancement treatment especially for sustainable agriculture.

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APPENDIES

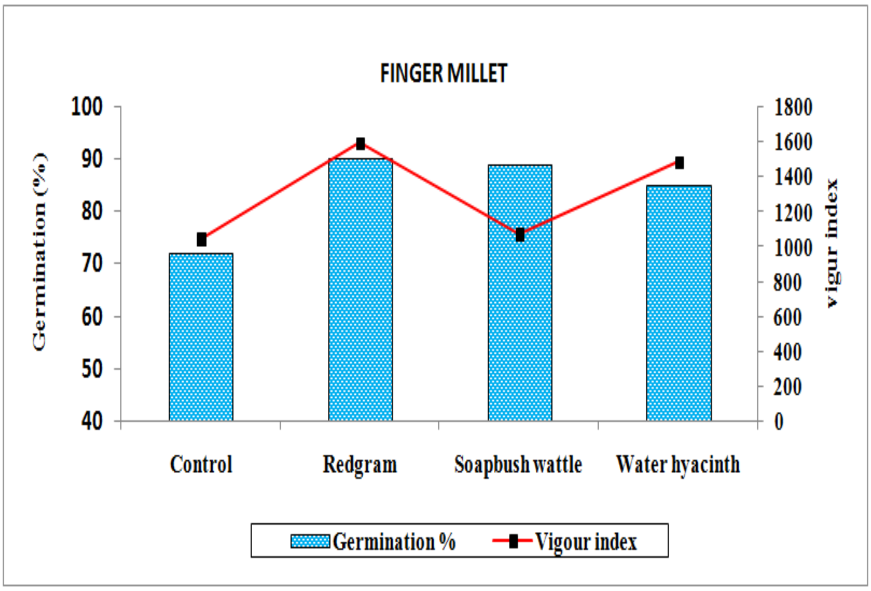

Figure 1: Evaluation of Different Biochars as Priming Agent for Seed Quality Performance

Table 1: Effect of Priming on Finger Millet Seed with Redgrambiochar as Priming Agent

Q. P / Conc.	Speed of Emergence	Germination %	Root Length (cm)	Shoot Length (cm)	Dry Matter Production (g/10 Seedlings)	Vigour Index
Control	3.79	75 (60.00)	11.0	3.4	0.019	1075
BC 1%	4.39	83 (65.65)	12.2	4.0	0.024	1337
BC 2%	4.65	85 (67.21)	12.7	4.0	0.024	1419
BC 3%	4.81	88 (69.73)	12.1	4.1	0.026	1425
BC 4%	4.82	91 (72.54)	13.3	4.2	0.028	1591
BC 5%	4.75	84 (66.42)	12.2	4.1	0.025	1369
Mean	**4.53**	**84 (66.92)**	**12.24**	**3.97**	**0.024**	**1369**
SEd	**0.14**	**2.6**	**0.60**	**0.16**	**0.002**	**74.5**
CD (P=0.05)	**0.31**	**5.1**	**1.31**	**0.36**	**0.004**	**162.3**

*Q. P- Quality Parameters, Conc.- Concentration, BC- Biochar
(Figures in parentheses indicates arcsine values)

Table 2: Effect of Priming on Finger Millet Seed with Soapbush Wattle Biochar as Priming Agent

Q. P / Conc.	Speed of Emergence	Germination %	Root Length (cm)	Shoot Length (cm)	Dry Matter Production (g/10 Seedlings)	Vigour Index
Control	4.30	75 (60.00)	11.0	3.4	0.020	1074
BC 1%	5.09	89 (70.63)	13.5	4.2	0.025	1582
BC 2%	4.85	87 (68.87)	12.9	4.2	0.023	1483
BC 3%	4.85	83 (65.65)	12.3	4.0	0.021	1347
BC 4%	4.99	81 (64.16)	12.3	4.2	0.025	1341
BC 5%	4.85	80 (64.23)	12.3	4.1	0.021	1310
Mean	**4.82**	**82 (65.53)**	**12.37**	**4.02**	**0.022**	**1356**
SEd	**0.22**	**2.6**	**0.42**	**0.16**	**0.001**	**68.9**
CD (P=0.05)	**0.48**	**5.8**	**0.91**	**0.35**	**0.002**	**150.2**

*Q. P- Quality Parameters, Conc.- Concentration, BC- Biochar
(Figures in parentheses indicates arcsine values)

Table 3: Effect of Priming on Finger Millet Seed with Water Hyacinth Biochar as Priming Agent

Q. P / Conc.	Speed of Emergence	Germination %	Root Length (cm)	Shoot Length (cm)	Dry Matter Production (g/10 Seedlings)	Vigour Index
Control	5.24	75 (60.00)	10.6	3.4	0.019	1050
BC 1%	5.81	81 (64.16)	12.5	3.8	0.021	1326
BC 2%	5.39	83 (65.65)	12.1	3.9	0.025	1325
BC 3%	5.47	84 (66.42)	12.2	4.0	0.023	1354
BC 4%	5.92	85 (67.21)	13.0	4.3	0.022	1483
BC 5%	5.84	77 (61.34)	12.9	4.0	0.024	1305
Mean	**5.61**	**80 (64.23)**	**12.20**	**3.89**	**0.022**	**1304**
SEd	**0.17**	**1.9**	**0.60**	**0.16**	**0.001**	**47.6**
CD (P=0.05)	**0.37**	**4.2**	**1.31**	**0.36**	**0.003**	**103.9**

*Q. P- Quality Parameters, Conc.- Concentration, BC- Biochar
(Figures in parentheses indicates arcsine values)